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OF THE

SIXTH ANNUAL TECHNICAL SEMINAR

PANEL DISCUSSION ON

EUTROPHICATION

JUNE 19, 1969

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F O R E W A R D

THE FOLLOWING IS A SUMMARY OF THE PROCEEDINGS OF THE SIXTH ANNUAL TECHNICAL SEMINAR OF THE OWRC PROFESSIONAL ENGINEERS' GROUP, HELD ON JUNE 19, 1969, AT THE COMMISSION LABORATORY IN TORONTO.

THE SEMINAR CONSISTED OF A PANEL DISCUSSION ON EUTROPHICATION FOLLOWED BY A QUESTION PERIOD.

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PANEL DISCUSSION ON EUTROPHICATION

MODERATOR - C. F. SCHENK,
Supervisor, Biology Branch,
Division of Laboratories, OWRC.

PANELISTS - DR. K. L. MURPHY,
Associate Professor,
Department of Chemical Engineering,
McMaster University.

DR. G. W. HEINKE,
Associate Professor,
Department of Civil Engineering,
University of Toronto.

S. E. SALBACH,
River Basin Surveys Program Engineer,
Water Quality Surveys Branch,
Division of Sanitary Engineering, OWRC.

DR. A. E. CHRISTIE,
Applied Sciences - Special Studies Branch,
Division of Research, OWRC.

Moderator: The form of this Seminar will consist of a series of questions prepared by the Technical Seminar Committee on the topic of eutrophication and the panel will have the opportunity to state their views. This will be followed by an open discussion from the floor.

Moderator: How significant is the accelerated eutrophication problem with respect to some of the other problems facing us at present, e.g. primary pollution including BOD and suspended solids and exotic pollution including pesticides, complex organic materials and heavy metals?

Dr. Murphy: I think that this is one problem which may have a number of viewpoints. The most common cause of fear is ignorance and if I start with this concept, the part of pollution I fear the most would be the exotic pollution, because I don't know very much about it or its affects on the aquatic environment. I worry, when I read a book like "The Silent Spring" by Rachel Carson, when I see the 21st Century talking about the isolation of DDT from penquins in the Antartic and telling us that the only known area free of DDT is a small area in the Aleutians. I think that is mainly why man should worry about exotic pollution, the rather resistant chemicals we have created, ones which apparently do defy biological attack or biological degradation.

I suppose if I were a lake trout living in Lake Erie, I would probably be more worried about eutrophication because this would be threatening my environment and my existence. Not being a lake trout, I am not too worried about eutrophication as it should not do more than affect the amenities of life. Consequently, I have to dismiss this as not being a real worry from the standpoint of human existence. As for the so-called carbonaceous demands such as BOD, primary pollution and suspended solids, I think really the only thing preventing complete cessation of this type of pollution is a lack of finances. We have techniques available to combat this form of pollution.

Dr. Heinke: The first comment that you made about the ignorance that we have with respect to pesticides, I would place that as the first problem from the research point of view. From the viewpoint of fiscal spending, I feel that, while there is considerable information on research on nutrient removal and effects on the environment, there is still a large divergence of opinion, and I would say, if I had money to spend, I would spend it on pollution needing secondary treatment. I don't think you can look at these problems and say that it is not something that is going to threaten my existence, I think we have to decide upon the kind of environment that we want to live in. I would not separate the primary pollution problem from the nutrient problem. After all, if inorganic material discharged creates algae that are nothing else but organic material, they are going to die, sink to the bottom and exert a BOD as much as any material coming from a treatment plant.

Dr. Christie: I agree that one of the greatest unknowns we have today is the extent of this exotic pollution. Materials like some insecticides tend to be concentrated along the food chain and these are ultimately going to end up in us, like it or not. We do not know how widespread exotic pollution is, if we did, we would have the problem solved. There has been a lot of concern in the States about substituting degradable pesticides for some of the relatively inert ones. We have a large number of compounds that we have not the faintest idea what they are going to do as far as the human being is concerned. I think this is one of the most dangerous areas in

the field of pollution.

With respect to eutrophication; certainly methods of controlling it have been suggested over the last forty years. It isn't a new problem. We probably just haven t the finesse to solve it. As for primary pollution, I think here it is a matter of money although I wouldn't necessarily classify BOD as primary pollution. I think it is also related to eutrophication.

Mr. Salbach: I don't think the question of money as emphasized by some of the panel members is of very great importance. Everything is dependent on money, whether it is primary, secondary, exotic or any other pollution control to resolve water quality problems caused by either BOD and solids or nutrients. One of the biggest differences with primary and eutrophication pollution is the time element involved. Primary pollution we can readily solve from one year to another by simply building sewage treatment plants. The eutrophication problem, however takes a long time to get rid of. We are talking in terms of twenty, fifty, one hundred years, in the case of Lake Erie even if the major nutrient inputs are significantly reduced. With primary pollution, we are well on our way to solving the problem. Our technology is advanced enough to cope with this problem. It is a matter of finances but so is eutrophication. As far as exotic pollution is concerned, I guess exotic implies something mysterious and unfortunately in many cases we don't know much about it.

Moderator: Two of the panel members have equated survival with the magnitude of the problems from the standpoint of pesticides. I wonder if it is worthwhile to think in terms of bringing it a little closer to us all; i.e., how important

is the insecticide problem here in Ontario? I think we have to limit our thinking to insecticides and pesticides in water. It seems to me that, while in general this is a very serious area of consideration, based on the most heavily used insecticide, DDT, and what we know about it, we have a good indication here in Ontario that they are not likely to present any great degree of human hazard at the present time. I think the work we have been involved in with the Department of Lands and Forests indicates that as far as water pollution is concerned, DDT is not really a serious problem so far in Ontario. With the steps now being taken, DDT use will be curtailed very drastically and the problem is not likely to become any more serious than it is at present.

We have to recognize the danger areas with other materials that are going to be used as alternatives. I have been greatly concerned because of the lack of research and there does not seem to be a means by which you can get the necessary attention focused on things which are important from our point of view as water quality managers. The Food and Drug people, for instance, require considerable information before they will permit a product to be used as an agricultural pesticide but there is nothing on the can, when the farmer goes to use it, that indicates that there is a hazard to water quality and he often ends up washing his equipment out in the streams. Perhaps he uses it a little heavier than he should and a heavy rain washes more into the stream. This is the sort of thing that is not being looked into sufficiently. The matter of transportation of these materials through various soil media

and the degradation in water -- these areas are not receiving sufficient attention.

Moderator: Before leaving this area, I would like to direct one question to Steve Salbach. Can we forego secondary or even primary treatment, is this possible and if so where can we do it?

Mr. Salbach: I have to make it clear that these comments are my own thoughts and not Commission policy. When we are talking about the Great Lakes, one wonders whether we really need secondary treatment. Does the effluent from secondary treatment plants create water quality problems? Most of the sewage plants along the Canadian shore of Lake Ontario have secondary treatment and I think our Commission has required these municipalities to have this degree of treatment. Yet, looking at it now, with our technology and knowledge of the fate of BOD in water and its effect on water quality and particularly dissolved oxygen, one questions whether secondary treatment is something that really should have been required. When looking at the long range problem, I think it would have been more beneficial to require nutrient removal.

My answer to your question, Carl, therefore is that in many cases, we could have foregone secondary treatment. On the other hand, we have to have primary treatment or a minimum type of treatment to take the major lumps, and what have you out to make sure we don't cause unsightly conditions.

I would like to make one comment on the question of pesticides. There is very little information available on the quantity of pesticides used. The Commission, as far as I know, is the only agency that has a permit system which requires

approval of the amounts of chemicals that are applied to water.

Dr. Murphy: I think it is time we really said what we mean by primary, secondary and tertiary treatment. If you consider Great Britain today, tertiary treatment means filtration. Generally they do not mean nutrient removal. I think it is time we talked about treatment in terms of what is really accomplished. Primary treatment which is really solids separation, secondary treatment the removal of dissolved and colloidal solids and then talk about either straining, filtration action or nutrient removal. What happens when you start precipitating phosphorus in a primary treatment unit? Are you then going to a primary-tertiary treatment and ignoring the secondary treatment? Or does your flocculation of colloids also constitute secondary treatment so that we now have primary, secondary and tertiary treatment all going on in a reactor of approximately onehour detention time?

I would like to comment on our Moderator's statement on pesticides. From the information I have there was no evidence that ABS was becoming much of a toxic element in our water and yet we witnessed the tremendous pressure to ban its use. Although there is little or no evidence that pesticides are at toxic levels, it surely would seem wise to consider or investigate similar action before the effects are felt.

Moderator: Can there be a general approach to nutrient removal policy in the Province and how specific can this be made?

Mr. Salbach: It is my opinion that we cannot afford not to think in terms of a general approach to nutrient removal. We should by all means have a nutrient removal policy. Phosphorus

has been singled out as the likely parameter to control the growth of algae or the eutrophication process. It may not be an economical solution to apply a general policy equally to small and large municipalities. I think that priorities will have to be established, where can we remove the largest amount of phosphorus for the smallest expenditure. The larger municipalities like Metropolitan Toronto, Rochester, and the Hamilton and St. Catharines area may be the first areas that should receive our attention. I think this is where our major efforts should be made. Nutrients in raw sewage are contributed at the rate of 3.5 lb/capita/year and about two-thirds of that is contributed by detergents. We can recognize from this that if we were to achieve the elimination of phosphorus from detergents we could resolve to a large degree our nutrient problems. We may have the smaller municipalities that cannot afford nutrient removal; it may be cheaper for the detergent industry to find a phosphorus substitute than to provide nutrient removal for all municipalities.

Dr. Christie: I am not so sure that we can take a general approach to the nutrient removal policy throughout the entire province. You will find in some areas there is already enough phosphorus to support algal blooms yet there are not any algal blooms there. In some cases, there is not enough carbon either. In the hard water lakes, certainly carbon is not limiting as far as algae go, except perhaps in exceptionally hard waters where we may get phosphorus precipitation. We really do not know where the phosphorus is coming from. For example, how much is being recycled from bottom muds? In soft water lakes, I think a lot of attention should be focused on carbon as well as phosphorus. I don't think a general

approach can be taken but instead a regional approach should be contemplated to the question of nutrient removal.

Dr. Heinke: Rather than look at the problem from a general approach of nutrient removal, I would like to see us take a look more at prevention in the first place. The thing that worries me is that even if we had the power to decide that nutrient removal is the answer, how long is it going to take before we in this Province are in fact going to have nutrient removal plants? Perhaps twenty or thirty years -- that is the order of magnitude we are talking about. I think we can reduce the problem of phosphorus content assuming that phosphorus is something to worry about. We could change the concentration of phosphorus in waste water in a matter of say two or three years, the time it would take to switch over to phosphate free detergent. The detergent industry claims there is not one chemical to replace phosphate, to do all the jobs that phosphates do. I think that is perfectly true -- there is not one chemical but there are a variety of chemicals that could perform the function that phosphates do. I think that this is one thing we are certainly going to have to look at -- that is prevention by not putting so much into the raw waste.

The second thing I would like to say is that we can control farming policies to some greater extent.

As far as a general policy of phosphorus removal in sewage treatment plants, I previously thought that we should analyse each particular basin with respect to phosphorus inputs. But phosphorus is unlike carbon in that it does not dissipate. It does not make any difference whether it enters Lake Ontario as sewage plant effluent or from a river. Since phosphorus is there to stay I might then say that phosphorus removal every-

where is required. As Al has already said, we don't know how much is released from muds. For all we know we may have already deposited enough phosphorus so even if we did provide complete phosphorus removal now there may be enough phosphorus in the bottom muds to ensure a problem for the next twenty years.

Dr. Murphy: The history of the removal of waste contaminants from effluents has never followed the laws of economics -- as I think one of our panelists has suggested, in terms of treating the effluent that is contributing the most contaminent. This policy has never been used widely in Ontario or in North America. I think that evidence for this statement was provided with the installation of secondary treatment at a place like Grimsby Beach which contributes only a negligible amount of pollution a year. A long outfall would have been much cheaper and more practical. With the savings we could then have devoted more attention to the large sources of pollution, i.e. Toronto, and installed even more complete carbon removal facilities. Certainly the total pounds of carbon from Toronto, even after secondary treatment, must far exceed the pounds of carbon discharged from Grimsby Beach. Be this as it may, we must take into account what is expedient and what we can do -- I don't think a uniform approach is necessary or even practical. I cannot really believe that there is an urgency to remove nutrients from waters entering James Bay. I doubt that the discharge of nutrients at Moosonee is going to have any serious affect on algae growth.

Mr. Salbach: I appear to be the only one in favour of a general nutrient removal policy for the Province. By not looking for

a general policy, we are almost forced into something like a classification system. I am not sure from an enforcement point of view that this is practical. We have to evaluate the local situation. We may not require nutrient removal for a river flowing north through uninhabited country but when it comes to Lake Erie, Lake Ontario or the upper lakes, like Lake Superior, if looking at the long range water resources management policy, it will be required to adopt a general nutrient removal policy. I feel my fellow panelists are looking at a short term policy.

Moderator: The next question, "Is phosphorus the critical element for practical purposes in water quality management?", relates very closely to the preceding question. Perhaps this topic has been exhausted -- does anyone have anything to add on this question.

Dr. Heinke: I feel to some extent that we are on a bit of a band wagon with the emphasis on phosphorus. I feel that what is the critical situation in one lake may not be the critical situation in another. Yet we can keep on researching and researching and do nothing about it because we may not know for sure that phosphorus is the critical element. I don t agree with this approach of research without foreseeable action.

Dr. Murphy: I have found in reading the recent literature that this is one area in which there is still a lot of conflict. I realize that it is generally accepted that phosphorus is the limiting nutrient but when you read the resumes on eutrophication you always come up with the feeling that maybe it is not as clear cut as it appears. Wuhrmann, from Switzerland, has claimed that both phosphorus and nitrogen may be the limiting

elements in particular situations. He points out that although phosphorus is very often the limiting nutrient, nitrogen can often limit growth as the cellular uptake rates are considerably different for phosphorus and nitrogen. Thus he states that nitrogen can be limiting at a much higher concentration. E. G. Fruh, at Texas, completely discounts most eutrophication studies made to date. He claims investigators mainly have measured only orthophosphate and only nitrate nitrogen. Furthermore, these measurements have been conducted during an algal bloom when you wouldn't expect to find these components present. I don't think we can say at this point that phosphorus is the critical element but I do not think I would deliberately put it into a lake. In terms of Lake Erie or for that matter the rest of the Great Lakes we are talking about a very large lake and cannot predict what the overall effect will be. If nitrogen, phosphorus and carbon are added and mixed well, a bloom will result. I would hesitate to add any of these things and hope that the other is the limiting source.

Dr. Christie: In 1967 I did a study on Lake of the Mountain; the lake is a nice place, does not really bloom, in fact, being mesotrophic by certain methods of classification. From this lake I took a sample from the upper layers in late July, brought it back to the lab, and added nitrate nitrogen at three different levels, no increase in algae. I did the same thing with phosphorus, as phosphate, and again nothing happened. But if I added the two together it supported considerable quantities of algae. This suggests that it is not necessarily phosphorus or necessarily nitrogen but at that particular time and that

particular place both were limiting so there was in actual fact a shortage of both nutrients. The report suggests that phosphorus not be added due to the possibility of nitrogen fixing algae causing a mess.

Mr. Salbach: Looking at this question, I like the words "for practical purposes", that is, the critical element for practical purposes in water quality management. Thinking about this in terms of the Great Lakes investigations, it has become quite obvious that the majority of phosphorus comes from municipal sources. We are talking in the order of sixty to seventy percent of total phosphorus discharged as opposed to twenty-five percent of nitrogen. We also know phosphorus run-off from land is lower than nitrogen run-off. The other point already made here is that appreciable amounts of nitrogen are contributed through rainfall. Another point is that nitrogen deficiency in lakes may cause the growth of algae that can fix nitrogen from the atmosphere. An equivalent phenomenon does not exist for phosphorus. The release of phosphorus from sediments is less both in percentage and magnitude than for nitrogen. In addition, our technology for the removal of phosphorus is well advanced compared to that for the removal of nitrogen. All these things, from a practical point of view and knowing if we limit phosphorus there should be a reduction in algae growth, tend to focus on phosphorus removal.

Moderator: What are the recommendations of the draft IJC report with respect to nutrients and if they are followed will the water quality situation in the Great Lakes be improved? Steve, with respect to the Great Lakes program, I suppose that you are closest to it, so are most qualified to answer this question.

Mr. Salbach: It should be obvious, perhaps it is not, but the content of the IJC report is confidential at this time. I cannot talk about the recommendations in that report.

Assuming there is a recommendation on nutrient removal, and if by nutrient removal we mean phosphorus removal, it becomes quite clear based on the comments we have made earlier that improvement in the Great Lakes will be quite slow. The water replacement time for Lake Ontario is 7.6 years and for Lake Erie is 2.3 years, that is simple water replacement time. We have gone through calculations for a conserved substance, that is, no biological uptake and sedimentation, and ninety percent removal of this substance will take about six to seven years for Lake Erie and twenty years for Lake Ontario. This will give you some idea of the time scale we are talking about.

Moderator: Perhaps we could carry some of your conservative assumptions a little bit further, Steve. Let us assume that perhaps the IJC report has a recommendation tailored towards maximizing the reduction of phosphorus by concentrating on the larger centres -- would this be a good move?

Dr. Murphy: For most of the big areas in North America, it would be a very good idea. Someone must pay for phosphorus removal and I do not imagine that Metropolitan Toronto Council would react favourably to being asked to remove phosphorus when it is the only municipality that has been asked in the Province. They would probably request a subsidy from the Province to cover the expense. I think that this is justifiable. If it is a Provincial decision to remove phosphorus, then the Province should bear the expenses.

Mr. Salbach: One point that has to be made clear is that when the IJC report does recommend nutrient removal, it will be up to the Commission to interpret it in the way they see fit.

Dr. Heinke: I think you are going to have to give some assurance to the City that to spend money on phosphorus removal, is going to be effective. I support the idea as long as there is some kind of chance for success based on a reasonable mass balance. Otherwise, I think we better use Provincial monies for something else.

Mr. Salbach: Our Commission is concerned with what happens in local areas along the shores of Lake Ontario and Lake Erie. It is hard to envision implementation of an overall nutrient removal policy for the Great Lakes basin because it is not feasible economically for the smaller municipalities. But I think we would achieve some solution to local problems if we did carry out phosphorus removal from detergents.

Moderator: I think we might be placing too much emphasis on arriving at a certain percentage removal and then missing the fact that we do have local situations where local problems persist. In Lake Ontario, for example, if you took away Cladophora, you'd hardly have any manifestation of the enrichment problem. Yet Cladophora creates a very serious condition affecting all the municipalities between the mouth of the Niagara and Kingston. This is the problem the people in these areas are concerned about. Local controls are necessary and would contribute to the overall benefit of Lake Ontario. We know from what is going on in Lake Huron at present, where you have a municipality discharging an effluent you get a local filamentous algae problem. From some analyses in these areas, we know the measurable

phosphorus is low, often as low as 0.01 mg/l. I think this is cause for concern relative to whether we can solve this aspect of the enrichment problem in Lake Erie or Lake Ontario. Will what we are ever going to accomplish in Lake Erie be sufficient to eliminate the Cladophora if we are only going to deal with phosphorus. I am not too sure that phosphorus, by itself, is the only consideration especially in Lake Erie.

Moderator: Before dropping the subject of the IJC report, let us make one more assumption that one of the recommendations is that phosphates in detergents should be banned. How should this be implemented and how fast should we expect the detergent industry to comply?

Dr. Heinke: I feel that it is going to take too long to build tertiary treatment plants. It has taken a long time to get primary and secondary treatment. By eliminating detergent phosphates we have an opportunity to, within a matter of three or four years, accomplish a high degree of phosphorus removal. I don't think we should do it through a law as the detergent industry has shown a fair amount of co-operation in getting ABS out. I think that we, as a group, made a mistake in going after them for ABS removal, we should have asked them for phosphorus removal. I think the time period for a phosphate substitute would be a matter of negotiation rather than an arbitrarily fixed period.

Moderator: Assuming that the IJC report is going to concentrate on Lake Erie and prevent further impairment of Lake Ontario, where does this leave us with respect to the Upper Lakes? Are we in danger of having too much attention relegated to the Lower Lakes at the expense of preventing local problems above? What should we be doing about the situation up there now, thinking

in terms of Collingwood, Meaford, and so on, relative to the nutrient question?

Dr. Christie: I think we should be concerned about any disruption of the natural conditions up there. Yet, until we can accurately assess what the critical effects of nutrient addition are in these areas, perhaps we should not contemplate doing anything as it may just be a waste of money.

Mr. Salbach: You know, I am wondering whether a panel in 1900 wouldn't have been saying the same thing about Lake Erie or Lake Ontario.

Dr. Christie: The question of percentage removals turns me off. You may have ninety-nine percent removal of phosphate but yet if you are still dumping too much, it really does not matter, does it? We don't know yet what kind of phosphorus level we want in any lake at any time to prevent a bloom. This is what we have to find out with respect to nitrogen, phosphorus and carbon and until we do I don't see any reason to advocate spending millions of dollars on nutrient removal to accomplish a given percentage removal. The techniques of nutrient removal have been known for years -- this is nothing new -- let us find out what we are aiming for in nutrient removal. Of course, one of the other aspects is to put the pressure on the detergent industry to remove the phosphate.

Dr. Heinke: Getting back to your question on the Upper Lakes, I think the thing we should do there is a continuous survey, that is, not just June, July, August and September, but all year round. We are all talking about how bad Lake Ontario and Lake Erie are but if you go and try to look at the back data you will find very little reliable information. For that matter, there is very little information on sewage plants. We have data for

the Great Lakes on calcium and other ions going back to 1900 but we have nothing on phosphates and if there is any data it is based on a method that was shown recently to give values ten times too high or only inorganic ortho-phosphate was considered which is meaningless by itself. Now, I think we have a chance to look at the Upper Lakes and start building up a bit of backlog of information so that we can watch what happens with these Lakes. Now we have to do backtracking on Lake Erie and Lake Ontario and hope that we make the right guesses but we have no information to go back on. We say nutrients have tremendously increased in the last ten or twenty years but who knows, we don't know the historical picture of phosphate content in Lake Erie or Lake Ontario. I think we should spend our money on research on the Upper Lakes.

Moderator: Is nutrient removal required in moving streams considerably remote from lakes, impoundments, etc?

Dr. Heinke: I don't think that question ought to be asked -- of course it should be removed. As far as phosphorus is concerned it just enters the stream and flows on down to the lake. It does not make any difference to that lake whether it comes from that stream or from a sewage plant. If the stream is close to a lake and we don't consider nutrients are a problem there, no, we don't need to remove it from the stream or the river. But if it is flowing into say Lake Erie and it is two hundred miles away, then I think it should be removed.

Moderator: Consideration of the uses of the river itself is obviously a point, also the character of the stream. If you are going to get into a filamentous algae problem with fish production affected by respiration with DO fluctuations then you have something to be considered in its own right. Generally

speaking we don't get into the problems with streams from the standpoint of bloom conditions. Nutrients are generally scoured out at times of high flows and the optimum conditions for high phytoplankton development do not usually occur.

Moderator: How do you differentiate between normal algal growth that can be tolerated, and nuisance productivity?

Dr. Murphy: I think it would depend principally on whether I owned a cottage on the water or whether I wanted to swim in it. In other words, the use of water is what governs our attitudes towards it.

Dr. Christie: It all depends on what use you want to put the water to. You certainly want a certain level of algal production in the water. It is the first step in the food chain. It is hard to put a number on these things -- I saw a reference this morning where they considered that 500 units/ml of algae was considered a bloom, but 500 Chlorella cells/ml and you would not even see it. A good green Chlorella culture was around 10^6 cells/ml. A healthy lake might run around 1000 ASU/ml. I would not want to get over 2 or 3000 cells/ml; then you might be into a scum.

Moderator: I think that this is difficult because it depends on what yardstick you are applying in each situation.

Moderator: Are the Commission's efforts on research and management aspects with respect to the eutrophication problem adequate?

Mr. Salbach: Because of the large financial implications associated with nutrient removal we should probably have some further research directed towards less expensive nutrient removal techniques. Another point already made is that we should try to find a suitable substitute to replace the phosphate in detergents. The effect of ceasing discharges of nutrient materials to Lake

Erie is one of the areas that should be further researched. What effect will complete cessation of nutrient discharge have and how long will it take to reduce the outflow concentration in Lake Erie? I think these should be the major research efforts in this area.

Moderator: Another essential, and your group should be intensively involved in this, is greater emphasis on establishing nutrient budgets for specific watersheds. It is my feeling that if you are going to come to grips with the nutrient problem, then you have to have a lot more definitive information as to the individual sources in any watershed. That is, the differences between the agricultural contribution, urban run-off, municipal and industrial effluent inputs and so on. I think a lot of the information that went into the IJC report was based on sketchy analyses.

Much more could be done in this area and the Commission should get off its high horse and start to deal effectively with the grass roots of this whole problem. A lot more is required in promoting local interest. I have spoken with people here at the lab about the fact that we really don't make use of the conservation authorities. These people are dealing with the municipalities. I think it would be a very effective tool if the Commission would actually get into the watershed areas and promote the establishment of committees to develop an awareness in individuals. We could really beef up our public relations and get out to people and make them understand their role in this business of water pollution control.

Dr. Heinke: Are there projects going on in pilot and small plants so that when and if the decision comes to implement nutrient removal, the Province is ready to do this? How many

consultants are there in this Province that know how to design a nutrient removal plant? What sort of background information do we have on success or failure?

Mr. Salbach: I don't believe this question is really fair. There are not many agencies in the world that have done as much on nutrient removal.

Moderator: Well I think we will cut this off here and get onto question from the floor.

Mr. Filman: I would like to direct my question to Steve Salbach. Steve, obviously you probably have made some estimate of the cost of phosphate removal. Could you give us some idea of how much it is going to cost to achieve a certain phosphorus removal percentage?

Mr. Salbach: There are several costs involved in nutrient removal. One -- the capital cost and the other, operating cost, which is the major cost because of large sludge production. To give an example, for a 10 mgd plant, you need about $500,000 for phosphorus removal. For ninety percent removal using alum the chemical costs are about $36 per million gallons. These are rough figures that have been reported.

Mr. Fielding: I would like to expand that question a little further. It has been mentioned that perhaps we should go after nutrient removal in Metropolitan Toronto because it is a big place. Do you have any figures indicating that it costs less per capita to remove a pound of phosphorus in Metropolitan Toronto than in Grand Bend. What I am getting at is it a per capita cost or big installation cost?

Mr. Salbach: The capital cost reduces with the size of the plant. This has been shown from data published in the United

States. But I think the main point is of course to get a maximum removal of nutrients entering the lake. There is very little difference in terms of chemical costs.

Mr. Trewin: I would like to ask Dr. Murphy to comment on whether he has given any consideration to this idea of nutrient removal by chemical precipitation and the economics of it?

Dr. Murphy: If you are referring to any research studies that we have made, the answer would be no. Interestingly enough, the sales literature from Dorr-Oliver claims that it is the effluent phosphorus concentration that governs the lime-alum dosage to be applied rather than the amount removed so they claim it is more economical to get it down to a low level in the primary treatment stage letting the biological system complete the removal.

Mr. Gotts: I was talking to some commercial fishermen in Lake Erie a few weeks ago. They say that from their nets in their boats just before they get to shore they discard something like seven million pounds of coarse fish that they are not even trying to catch. What would be the possibility, rather than taking phosphorus out at the source, to harvest these fish and put them through a meal plant to provide food supplements for poultry and so on or convert them to fertilizers even if the plant requires a subsidy to make it go?

Mr. Neil: I made some calculations about this at one time and the amount of phosphorus taken out by commercial fishing is in the order of one hundred thousand pounds a year compared to the contribution from eleven million people.

Mr. Salbach: I think this is substantiated to some extent by some of the work done in the Great Lakes study. The amount of

nutrient taken out in total fish catch is insignificant.

Dr. Heinke: I have some figures here that indicate the concentration of nitrogen in fish is 2.5% and in phosphorus 0.2% meaning that you need to take out five hundred pounds of fish to take out one pound of phosphorus.

Mr. Johnson: I don't believe that we can write off all bodies of water as inevitably progressing to marshes. I don't think we should believe anyone who states that Lake Erie has aged twenty thousand years in the last hundred years. The question I would like to ask is, if you had a lake where phosphorus was not limiting but it came close to being limiting, maybe the second or third most important nutrient, and if you removed most of that phosphorus, how in the world can production remain at the same level?

Mr. Johnson: This point came up at the previous discussion on nutrients. John Thon brought up the point that you don't have to remove the nutrient that is "most Limiting". John Thon's point was quite practical, that is, to remove something that can be removed and then it becomes limiting.

Mr. Neil: With further research and understanding, I think we should be able to determine the physical state that we want to be in. I don't think that eutrophication is something that is universal. Maybe we should take Ron Gotts' approach and chemically harvest phosphorus and return it to the land. I think we should be looking towards developing a state of knowledge of limnology such as they have in agriculture.

Dr. Brydges: I wonder if we are not being pessimistic when we are saying it is going to take fifty or sixty years for Lake Erie to clean up.

Mr. Jeffs: I would like to ask Al Christie whether algae pick up some of the exotic chemicals which we are talking about such as pesticides?

Dr. Christie: There is not really that much evidence on the assimilation of insecticides by algae. In our studies, algae did not take up very much DDT but of course this is a problem of solubility, DDT being only 1.2 ppb soluble.

Moderator: They put some DDT into an Illinois swamp and they found a tremendous uptake of this material. It went through all of the biota in the swamp right up to reptiles. In spite of the limited solubility of DDT in water everything latches onto it.

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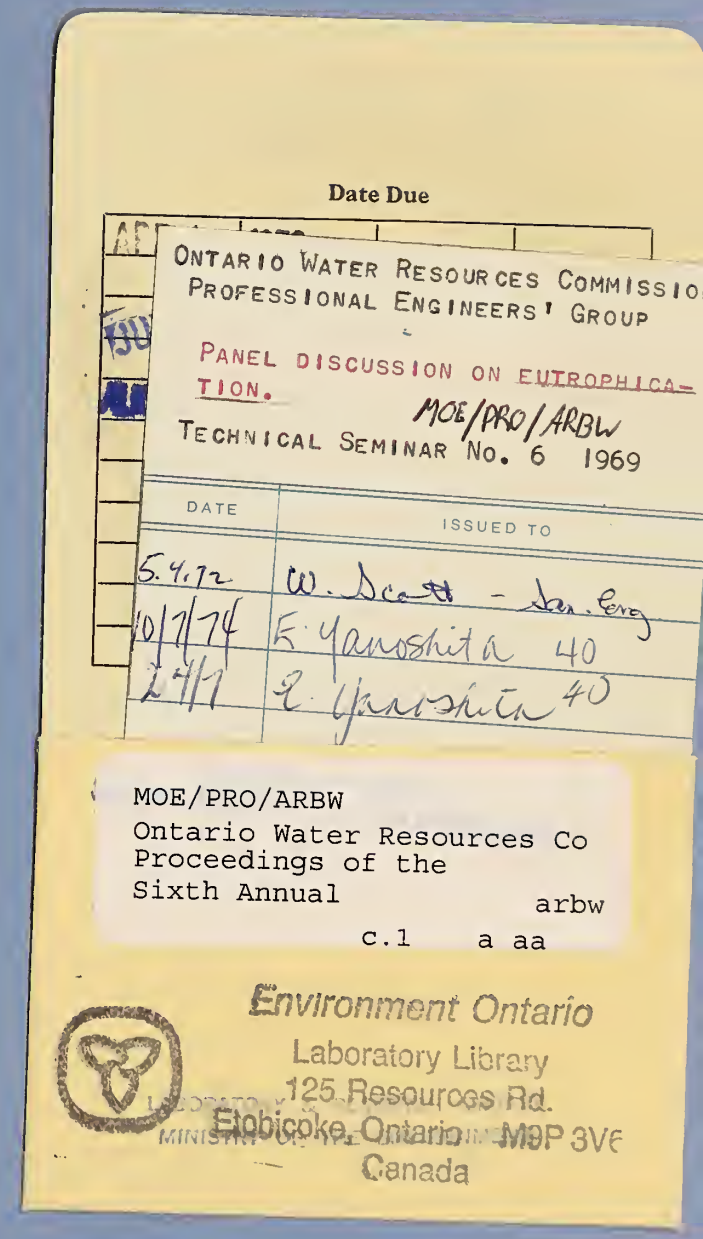

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